

REMARKS

An excess claim fee payment letter is submitted herewith for twelve (12) additional total claims.

Claims 1-32 are all the claims presently pending in the application. Claim 3 is amended to more clearly define the invention and claims 4-32 are added. Claims 1 and 16 are independent.

These amendments are made only to more particularly point out the invention for the Examiner and not for narrowing the scope of the claims or for any reason related to a statutory requirement for patentability.

Applicants also note that, notwithstanding any claim amendments herein or later during prosecution, Applicants' intent is to encompass equivalents of all claim elements.

Claims 1 and 3 stand rejected under 35 U.S.C. § 102(b) as being anticipated by the Shimizu et al. reference. Claim 2 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over the Shimizu et al. reference in view of the Cheng et al. reference.

These rejections are respectfully traversed in the following discussion.

I. THE CLAIMED INVENTION

An exemplary embodiment of the claimed invention, as defined by, for example, independent claim 1, is directed to an electric power steering apparatus adapted to transmit power supplied from an electric motor for assisting steering. The electric power steering apparatus includes a driving gear and a driven gear through which the power is transmitted. The backlash between the driving gear and the driven gear is set at least in a neighborhood region of a steering neutral position to be smaller than that in a remaining region.

Conventional electric power steering apparatuses try to strike a balance between a large backlash which reduces resistance to steering assistance, but which increases the amount of noise due to steering feedback from the tires of the vehicle, and a small backlash which increases resistance to steering assistance, but which reduces the steering feedback noise. However, these systems have provided a backlash which provides a proper balance.

In stark contrast, the present invention provides a proper balance by providing a backlash between the driving gear and the driven gear that is set at least in a neighborhood region of a steering neutral position to be smaller than that in a remaining region. In this manner, the present invention obtains the benefits of a smaller backlash in the neighborhood region of a steering neutral position and the benefits of a larger backlash in a remaining region. Thus, the present invention both reduces resistance to steering assistance from a steering assist motor and also suppresses noise due to steering feedback from the tires. (Page 2, line 22 - page 3, line 22).

II. THE PRIOR ART REJECTIONS

A. The 102(b) Shimizu et al. reference rejection

Regarding the rejection of claims 1 and 3, the Examiner alleges that the Shimizu et al. reference teaches the claimed invention. Applicants submit, however, that there are elements of the claimed invention which are neither taught nor suggested by the Shimizu et al. reference.

The Shimizu et al. reference does not teach or suggest the features of the present invention including: 1) a backlash between a driving gear and a driven gear that is set at least in a neighborhood region of a steering neutral position to be smaller than that in a remaining

region (claim 1); and 2) a backlash between a driving gear and a driven gear that is smaller in a first range of operation than a second range of operation (claim 4). As explained above, these features are important for providing the benefits of both reducing resistance to steering assistance from a steering assist motor and also of suppression the generation of noise due to steering feedback from the tires of a vehicle.

The Shimizu et al. reference teaches that “the tooth surfaces of the driver gear and/or the tooth surfaces of the driven gear are coated with a low friction material coatings (sic) and the driver gear and driven gear mesh with no backlash.” (Emphasis added, col. 3, lines 46-49).

The Shimizu et al. reference further explains that “By thus meshing driver gear and driven gear with no backlash, there is no play between the driver and driven gears, and impact torque due to motor inertia does not pass from the driver gear tooth surface to the driven gear tooth surface.” (Emphasis added, col. 3, lines 53-57).

Further, the Shimizu et al. reference describes an exemplary embodiment that is “characterized by causing the teeth of worm 112 and the teeth of worm 113 to mesh with no backlash. The means whereby backlash is eliminated is achieved, for example, by some combination of the following four factors.” (Emphasis added, col. 11, lines 17-21).

Applicants note that only two of the factors listed by the Shimizu et al. reference actually affect the backlash. The first two factors of coating the tooth surfaces with a low friction coefficient material and using a resin or plastic worm wheel (col. 11, lines 22-25) have absolutely no effect upon backlash.

However, while the third and fourth factors of setting the distance between the centers of the gears and setting the pitch circle diameter of the worm or of the worm wheel to a

slightly greater value affect backlash (col. 11, lines 26-33), the Shimizu et al. reference does not teach or suggest setting a backlash between a driving gear and a driven gear that is smaller in a first range of operation than a second range of operation.

Rather, and in stark contrast, the Shimizu et al. reference only teaches setting backlash to zero across the entire range of operation.

Additionally, the Shimizu et al. reference does not teach or suggest anything at all that is even remotely related to a steering neutral position, let alone that a backlash in a neighborhood region of a steering neutral position is smaller than that of a remaining region as recited by claim 1.

Indeed, the Shimizu et al. reference does not even distinguish between a first range of operation and a second range of operation at all, let alone that the backlash in the first range of operation is smaller than in the second range of operation as recited by claim 4.

Therefore, the Shimizu et al. reference does not teach or suggest each and every element of the claimed invention and the Examiner is respectfully requested to withdraw this rejection of claims 1 and 3.

B. The Shimizu et al. reference in view of the Cheng et al. reference

The Examiner alleges that the Cheng et al. reference would have been combined with the Shimizu et al. reference to form the claimed invention. Applicants submit, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Applicants submit that these references would not have been combined as alleged by the Examiner. Indeed, the references are directed to completely different matters and

problems.

Specifically, the Shimizu et al. reference is directed to improving the durability, transfer efficiency and strength of a rack and pinion mechanism (col. 2, lines 20 - 31).

In stark contrast, the Cheng et al. reference is specifically directed to the completely different and unrelated problem of reducing backlash within an electric steering assist apparatus without experiencing high wear and tear and rapid deterioration of such a mechanism (col. 1, lines 15 - 67).

One of ordinary skill in the art who was concerned with improving the durability, transfer efficiency and strength of a rack and pinion mechanism as the Shimizu et al. reference is concerned with providing would not have referred to the Cheng et al. reference because the Cheng et al. reference is only concerned with the completely different and unrelated problem of reducing backlash within an electric steering assist apparatus without experiencing high wear and tear and rapid deterioration of such a mechanism. Thus, the references would not have been combined.

Moreover, even assuming arguendo that one of ordinary skill in the art would have been motivated to combine these references, the combination would not teach or suggest each and every element of the claimed invention.

As explained above, the Shimizu et al. reference does not teach or suggest the features of the present invention including: 1) a backlash between a driving gear and a driven gear is set at least in a neighborhood region of a steering neutral position to be smaller than that in a remaining region (claim 1); and 2) a backlash between a driving gear and a driven gear is smaller in a first range of operation than a second range of operation (claim 4). As explained above, these features are important for providing the benefits of both reducing resistance to

steering assistance from a steering assist motor and also of suppression the generation of noise due to steering feedback from the tires of a vehicle.

The Cheng et al. reference does not remedy the deficiencies of the Shimizu et al. reference.

Rather, the Cheng et al. reference teaches providing integrally molded plastic gear teeth that are flanked on at least one side by an outer cylindrical wall of a worm. For example, the Cheng et al. reference discloses providing a plastic tooth ring 84 that is molded onto a worm gear 64. The plastic tooth ring 84 is molded from a material that has a substantially more resilient flexibility than the material of the worm gear 64 (col. 4, lines 19-22). Further, the plastic tooth ring 84 includes teeth that each have a pair of flanks 96A and 96B which circumferentially overlap the flanks 78A and 78B of the teeth of the worm gear 64.

The Cheng et al. reference further discloses that the flanks 96A and 96B of the plastic tooth ring 84 engage the gear teeth 58 of a worm 56 with zero dimensional clearance, i.e., lash (emphasis added, col. 4, lines 54-57), while the flanks 78A and 78B of the gear teeth of the worm gear 64 are separated from the flanks of the teeth of the worm 56 (col. 4, lines 60-62).

In other words, the Cheng et al. reference discloses zero backlash between the plastic tooth ring 84 and the worm 56, and a greater than zero backlash between the worm gear 64 and the worm 56.

However, the Cheng et al. reference does not teach or suggest anything at all that is even remotely related to a steering neutral position, let alone that a backlash in a neighborhood region of a steering neutral position is smaller than that of a remaining region.

as recited by claim 1.

Rather, and in stark contrast, the Cheng et al. reference clearly discloses that the backlash between the plastic tooth ring 84 and the worm 56 and the backlash between the worm gear 64 and the worm 56 does not change in relation to any range of operation at all. Indeed, the backlashes between the plastic tooth ring 84 and the worm 56 and between the worm gear 64 and the worm 56 never changes.

Similarly, the Cheng et al. reference clearly does not teach or suggest anything at all that is even remotely related to a first range of operation and a second range of operation at all, let alone that the backlash in the first range of operation is smaller than in the second range of operation as recited by claim 4.

Clearly, the Cheng et al. reference does not remedy the deficiencies of the Shimizu et al. reference.

Therefore, the Examiner is respectfully requested to withdraw the rejection of claim 2.

III. FORMAL MATTERS AND CONCLUSION

In view of the foregoing amendments and remarks, Applicants respectfully submit that claims 1-32, all the claims presently pending in the Application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the Application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

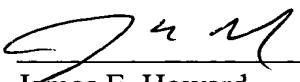
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15

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

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